



AEROSPACE MATERIAL SPECIFICATION

AMS5333™

REV. G

Issued 1955-03

Revised 2017-09

Reaffirmed 2022-06

Superseding AMS5333F

Steel, Investment Castings
0.50Cr - 0.55Ni - 0.25Mo (0.11 - 0.17C) (SAE 8615)

Normalized

(Composition similar to UNS J11442)

RATIONALE

AMS5333G results from a Five-Year Review and update of this specification that revises check analysis (3.1.2), radiographic acceptance (3.7.4.1), reporting (4.5), and adds a requirement to report exceptions to technical requirements (4.5.1).

AMS5333G has been reaffirmed to comply with the SAE Five-Year Review policy.

1. SCOPE

1.1 Form

This specification covers a low-alloy steel in the form of investment castings.

1.2 Application

These castings have been used typically for small parts of intricate design which may require surface hardening by carburizing, but usage is not limited to such applications.

2. APPLICABLE DOCUMENTS

The issue of the following documents in effect on the date of the purchase order forms a part of this specification to the extent specified herein. The supplier may work to a subsequent revision of a document unless a specific document issue is specified. When the referenced document has been cancelled and no superseding document has been specified, the last published issue of that document shall apply.

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

AMS2175 Castings, Classification and Inspection of

AMS2259 Chemical Check Analysis Limits Wrought Low-Alloy and Carbon Steels

AMS2694 In-Process Welding of Castings

AMS2804 Identification Castings

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For more information on this standard, visit

<https://www.sae.org/standards/content/AMS5333G/>

AMS-H-6875 Heat Treatment of Steel Raw Materials

ARP1917 Clarification of Terms Used in Aerospace Metals Specifications

2.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM E18 Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials

ASTM E140 Hardness Conversion Tables for Metals Relationship Among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial Hardness, Knoop Hardness, Scleroscope Hardness, and Leeb Hardness

ASTM E350 Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron

ASTM E1417 Liquid Penetrant Testing

ASTM E1444 Magnetic Particle Testing

ASTM E1742 Radiographic Examination

3. TECHNICAL REQUIREMENTS

3.1 Composition

Castings shall conform to the percentages by weight shown in Table 1 determined by wet chemical methods in accordance with ASTM E350, by spectrochemical methods, or by other analytical methods acceptable to purchaser (see 8.2.1 and 8.2.2).

Table 1 - Composition

Element	Min	Max
Carbon	0.11	0.17
Manganese	0.65	1.00
Silicon	0.50	1.00
Phosphorus	--	0.04
Sulfur	--	0.04
Chromium	0.35	0.65
Nickel	0.35	0.75
Molybdenum	0.15	0.35
Copper	--	0.35

3.1.1 Producer may test for any element not otherwise listed in Table 1 and include this analysis in the report of 4.5. Limits of acceptability may be specified by purchaser (see 8.2.3).

3.1.2 Check Analysis

Composition variations shall meet the applicable requirements of AMS2259.

3.2 Melting Practice

Castings shall be poured at casting producer's facility either from a melt (see 8.2.4) of a master heat or directly from a master heat (see 8.2.5).

3.2.1 Revert (gates, sprues, risers, and rejected castings) may be used only in the preparation of master heats; revert shall not be remelted directly, without refining, for pouring of castings. Melting of revert creates a new master heat.

- 3.2.2 Portions of two or more qualified master heats (see 3.4.1) may be melted together and poured into castings using a procedure authorized by purchaser (see 8.2.6).
- 3.2.3 If modifications, such as alloy additions or replenishments, are made by the producer at remelt, producer shall have a written procedure acceptable to purchaser (see 8.2.1) which defines the controls, test, and traceability criteria for castings. Control factors of 4.4.2.2 shall apply.

3.3 Condition

Castings shall be delivered in the normalized condition.

3.4 Test Specimens

- 3.4.1 Each master heat shall be qualified by evaluation of a chemical analysis specimen.

- 3.4.1.1 If alloy additions or replenishments are made at remelt as in 3.2.3, the frequency of sampling and testing used by the producer for qualification to 3.4.1 shall be acceptable to purchaser.

3.4.2 Chemical Analysis Specimens

Shall be of any convenient size and shape.

3.5 Heat Treatment

Castings shall be heat treated in accordance with AMS-H-6875, except as specified in 3.5.1.

3.5.1 Normalize

Heat to a selected temperature in the range 1700 to 1750 °F (927 to 954 °C), in an atmosphere neutral to the specified carbon range, hold at heat for not less than one hour, and cool at a rate equivalent to that obtained in still air.

3.6 Properties

Castings shall conform to the following requirements:

3.6.1 Hardness of Castings

Shall be not higher than 90 HRB, or equivalent (see 8.3) determined in accordance with ASTM E18:

3.6.2 Carburization or Decarburization

The carbon content shall be within the limits of 3.1 throughout the casting except within 0.003 inch (0.08 mm) of the surface.

3.7 Quality

- 3.7.1 Castings, as received by purchaser, shall be uniform in quality and condition, sound, and free from foreign materials and from imperfections detrimental to usage of the castings. Castings shall be free of cracks, laps, hot tears, and cold shuts, and shall be free of scale and other process-induced surface contamination which would obscure defects.

- 3.7.2 Castings shall be produced under radiographic control. This control shall consist of radiographic examination of each casting part number until foundry manufacturing controls, in accordance with 4.4.2, have been established. Additional radiography shall be conducted in accordance with the frequency of inspection specified by purchaser or as necessary to ensure continued maintenance of internal quality.

- 3.7.2.1 Radiographic inspection shall be conducted in accordance with ASTM E1742 or other method specified by purchaser.

- 3.7.3 When specified, castings shall be subjected to additional nondestructive testing as follows:

- 3.7.3.1 Fluorescent penetrant inspection in accordance with ASTM E1417 or other method specified by purchaser.
- 3.7.3.2 Magnetic particle inspection in accordance with ASTM E1444 or other method specified by purchaser.
- 3.7.4 Acceptance standards for radiographic, fluorescent penetrant, magnetic particle, visual, and other inspection methods shall be as agreed upon by purchaser and producer (see 8.2.7). AMS2175 may be used to specify acceptance standards (casting grade) and frequency of inspection (casting class).
 - 3.7.4.1 When acceptance standards are not specified, Grade C of AMS2175 shall apply and radiographic indications of gas holes, sand spots, and inclusions shall be cause for rejection when closer to the edge than twice their maximum dimension.
- 3.7.5 Castings shall not be peened, plugged, impregnated, or welded unless authorized by purchaser.
- 3.7.5.1 When authorized by purchaser, welding in accordance with AMS2694 or other welding program acceptable to purchaser may be used.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The producer of castings shall supply all samples for producer's tests and shall be responsible for the performance of all required tests. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the castings conform to specified requirements.

4.2 Classification of Tests

4.2.1 Acceptance Tests

Composition (3.1), hardness (3.6.1), and applicable requirements of quality (3.7) are acceptance tests and shall be performed as specified in 4.3.

4.2.2 Periodic Tests

Carburization/decarburization (3.6.2) and radiographic soundness (3.7.2) are periodic tests and shall be performed at a frequency selected by the producer unless frequency of testing is specified by purchaser.

4.2.3 Preproduction Tests

All technical requirements are preproduction tests and shall be performed on sample castings (4.3.2), when a change in control factors occurs (4.4.2.2), and when purchaser deems confirmatory testing to be required.

4.3 Sampling and Testing

The minimum testing performed by producer shall be in accordance with the following:

- 4.3.1 One chemical analysis specimen or a casting from each master heat shall be tested for conformance with Table 1; if 3.4.1.1 applies, test frequency shall be acceptable to purchaser.
- 4.3.2 One preproduction casting in accordance with 4.4 shall be tested to the requirements of the casting drawing and to all technical requirements.
 - 4.3.2.1 Dimensional inspection sample quantity shall be as specified by purchaser.
- 4.3.3 Castings shall be inspected in accordance with 3.7 to the methods, frequency, and acceptance standards specified by purchaser.
- 4.3.4 Unless otherwise specified by purchaser, one casting from each lot shall be tested for hardness to determine conformance with 3.6.1.

4.3.4.1 In the event of failure, the entire lot shall be 100% inspected or reheat treated in accordance with 4.6.2.

4.4 Approval

4.4.1 Sample casting(s) from new or reworked master patterns produced under the casting procedure of 4.4.2 shall be approved by purchaser before castings for production use are supplied, unless such approval is waived by purchaser.

4.4.2 For each casting part number, producer shall establish parameters for process control factors that will consistently produce castings meeting the requirements of the casting drawing and this specification. These parameters shall constitute the approved casting procedure and shall be used for production of subsequent castings. If necessary to make any change to these parameters, producer shall submit a statement of the proposed changes for purchaser reapproval. When requested, producer shall also submit sample castings to purchaser for reapproval.

4.4.2.1 Production castings produced prior to receipt of purchaser's approval shall be at producer's risk.

4.4.2.2 Control factors for producing castings include, but are not limited to, the factors shown below. Producer's procedures shall identify tolerances, ranges, and/or control limits, as applicable.

Composition of ceramic cores, if used

Arrangement and number of patterns in the mold

Size, shape, and location of gates and risers

Mold refractory formulation

Grain refinement methods, if applicable

Mold backup material (weight, thickness, or number of dips)

Type of furnace, atmosphere, and charge for melting

Mold preheat and metal pouring temperatures

Fluxing or deoxidation procedure

Replenishment and alloy addition procedures, if applicable

Time molten metal is in furnace

Solidification and cooling procedures

Cleaning operations (mechanical and chemical)

Welding procedure, if applicable

Heat treatment

Straightening

Final inspection methods.

4.4.2.2.1 Any of the control factors of 4.4.2.2 for which parameters are considered proprietary by the producer may be assigned a code designation. Each variation in such parameters shall be assigned a modified code designation.

4.4.2.2.1.1 Unless otherwise agreed upon by purchaser and producer, purchaser shall be entitled to review proprietary control factor details and coding at producer's facility.

4.5 Reports

The producer of castings shall furnish with each shipment a report showing the producer identity, country where the metal was melted (e.g., final melt in the case of metal processed by multiple melting operations) and the results of tests to determine conformance to the acceptance test requirements. This report shall include the purchase order number, master heat identification, heat treat/lot identification, AMS5333G, part number, and quantity.

4.5.1 When exceptions are taken to the technical requirements listed in Section 3, the report shall contain a statement "This material is certified as AMS5333G(EXC) because of the following exceptions:" and the specific exceptions shall be listed.

4.6 Resampling and Retesting

If results of a valid test fail to meet specified requirements, except as in 4.3.4.1, two additional samples in accordance with 4.3 from the same master heat, modified melt (see 3.2.3), or lot as applicable, shall be tested for each nonconforming characteristic. The results of each additional test, and the average of the results of all tests (original and retests), shall meet specified requirements; otherwise, the master heat or lot shall be rejected. Results of all tests shall be reported.